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(54) **AUDIO CHANNEL CONVERSION**

TONKANALKONVERTIERUNG

CONVERSION DE CANAL AUDIO

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(73) Proprietors:
• **Koninklijke Philips Electronics N.V.
5621 BA Eindhoven (NL)**
• **Dolby Sweden AB
113 30 Stockholm (SE)**

(72) Inventors:
• **BREEBAART, Dirk, J.
NL-5656 AA Eindhoven (NL)**
• **SCHUIJERS, Erik, G., P.
NL-5656 AA Eindhoven (NL)**
• **PURNHAGEN, Heiko
S-113 52 Stockholm (SE)**
• **RÖDÉN, Karl, J.
S-113 52 Stockholm (SE)**

(74) Representative: **Zinkler, Franz et al
Schoppe, Zimmermann, Stöckeler & Zinkler
Patentanwälte
Postfach 246
82043 Pullach bei München (DE)**

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Description

[0001]   The present invention relates to audio channel conversion. More in particular, the present invention relates to a device and a method for converting a first number of input audio channels into a second number of output audio channels, the first number being smaller than the second number.

[0002]   It is well known to convert a number of audio channels into another, larger number of audio channels. This may be done for various reasons. A first reason may be the conversion into a new format. Stereo recordings, for example have only two channels, while modem audio systems typically have five or six channels, as in the popular "5.1" systems. Accordingly, the two stereo channels have to be converted into five or six channels in order to take full advantage of the advanced audio system. The second reason may be coding efficiency. It has been found that stereo audio signals can be encoded as single channel audio signals combined with a parameter bit stream describing the spatial properties of the audio signal. The decoder can reproduce the stereo audio signals with a very satisfactory degree of accuracy. In this way, substantial bit rate savings may be obtained.

[0003]   There are several parameters which describe the spatial properties of audio signals. One of those parameters is the inter-channel cross-correlation, for example in stereo signals the cross-correlation between the L channel and the R channel. Another parameter is the power ratio of the channels. In so-called parametric spatial audio (en)coders these and other parameters are extracted from the original audio signal so as to produce an audio signal having a reduced number of channels, for example only a single channel, plus a set of parameters describing the spatial properties of the original audio signal. In so-called parametric spatial audio decoders the original audio signal is substantially reconstructed.

[0004]   A parametric spatial audio decoder typically comprises a number of decorrelation filters for producing sets of decorrelated auxiliary channels of each input audio channel. These decorrelated auxiliary channels are then combined with the original input channels in a so-called upmix unit to produce output channels having a desired correlation, that is, a correlation corresponding with the original audio signal. In addition to setting the correlation, the upmix unit typically also sets the power ratio of the audio channels and/or carries out other signal processing steps, such as predicting an audio channel on the basis of other channels see for example "Synthetic ambience in parametric stereo coding", from ENGDEGARD et al. in 116th AES Convention.

[0005]   The present inventors have found that the decorrelation filters introduce a time delay and a temporal "smearing" of the audio signal and that, as a resuit of this, there may be a temporal discrepancy between a signal part (for example the signal contained in a time frame) and its corresponding parameters: as the signal part is delayed, its parameters may be applied to another signal part, resulting in distortion of the signal. This is clearly undesirable. It is, however, not feasible to delete the decorrelation units from the decoder, as this would make it impossible to provide audio channels having a correct inter-channel correlation.

[0006]   It is an object of the present invention to overcome these and other problems of the Prior Art and to provide a device and a method for converting the number of audio channels of an audio signal in which the disadvantageous effects of the decorrelation filters are significantly reduced or even eliminated.

[0007]   Accordingly, the present invention provides a device as claimed in claim 1, for converting a first number of input audio channels into a second number of output audio channels, where the first number is smaller than the second number, the device comprising:

- at least one decorrelation unit for producing a set of decorrelated auxiliary channels from an input audio channel, the set of decorrelated auxiliary channels including one or more decorrelated auxiliary channels; and
- at least one upmix unit for combining channels into output audio channels, wherein the at least one upmix unit is operative to combine an input audio channel or a pre-processed input audio channel and a decorrelated auxiliary channel based on a time-varying inter-channel cross correlation parameter, said device further comprising:

- at least one pre-processing unit for pre-processing the input audio channel prior to feeding the input audio channel to the at least one decorrelation unit, wherein the at least one pre-processing unit is operative to perform a time-varying signal processing other than setting correlations.

[0008]   By providing a pre-processing unit for pre-processing the input audio channels prior to processing by the decorrelation units, the audio channels can be (pre-)processed before any delay or "smearing" is introduced by the decorrelation units. As a result, the correct parameters are used for this processing and any misalignment of the signal parts and the parameters is avoided.

[0009]   The at least one pre-processing unit is arranged such that the pre-processing takes place before the input audio channel is fed to the decorrelation unit(s). Accordingly, the pre-processing unit is arranged between an input terminal of the device and the at least one decorrelation unit.

[0010]   The set of auxiliary channels derived from a single input audio channel may consist of one, two, three or more channels, Auxiliary channels may also be derived from intermediate channels, that is channels derived from the input

audio channels by signal processing other than decorrelation, for example by prediction, as may be performed in the pre-processing unit of the present invention.

[0011] The upmix unit(s) may combine the input audio channel (or channels), the decorrelated auxiliary channel (or channels) and/or any intermediate channels in a known manner. In addition to combining (that is, mixing), the upmix unit may also perform scaling. However, in accordance with the present invention the processing of the auxiliary channels and the input audio channels, other than combining, is primarily or exclusively performed in the pre-processing unit.

[0012] The pre-processing unit(s) and/or the upmix unit(s) are preferably controlled by audio parameters. These units are therefore designed to be controlled by these units. This provides a greater flexibility and allows the pre-processing properties and/or upmix properties to be changed.

[0013] Accordingly, the pre-processing unit is preferably arranged for time-variant pre-processing. That is, the processing performed by the pre-processing units varies with time. More in particular, this processing is determined by time-varying signal parameters. The upmix unit is preferably also arranged for time-variant processing, such as time-variant decorrelation. In contrast, the decorrelation units are preferably arranged for time-invariant decorrelation.

[0014] The pre-processing unit(s) may advantageously be arranged for setting power ratios of audio channels and/or prediction. This prediction involves predicting the signals of certain audio channels on the basis of properties of other channels and prediction parameters.

[0015] It is noted that setting the correlations of the audio channels should be performed after the decorrelation units, that is, by the conventional upmix unit. All other signal processing, however, may take place in the pre-processing unit.

[0016] The present invention also provides an audio system comprising a device as defined above. The audio system may further comprise one or more audio sources, an amplifier and loudspeaker units or their equivalents.

[0017] The present invention additionally provides a method, as claimed in claim 10, of converting a first number of input audio channels into a second number of output audio channels, where the first number is smaller than the second number, the method comprising the steps of:

- producing a set of decorrelated auxiliary channels from an input audio channel, the set of decorrelated auxiliary channels including one or more decorrelated auxiliary channels; and
- combining channels into output audio channels, wherein the step of combining comprising combining an input audio channel or a pre-processed input audio channel and a decorrelated auxiliary channel based on a time-varying inter-channel cross correlation parameter, said method comprising the additional step of:

- pre-processing the input audio channel prior to the step of producing the set of decorrelated auxiliary channels from the input audio channel, wherein the step of pre-processing comprises performing a time-varying signal processing other than setting correlations.

[0018] Preferably, audio parameters are used for controlling the combining step and the pre-processing step.

[0019] The present invention further provides a computer program product, as claimed in claim 13, for carrying out the method as defined above. A computer program product may comprise a set of computer executable instructions stored on a data carrier, such as a CD or a DVD. The set of computer executable instructions, which allow a programmable computer to carry out the method as defined above, may also be available for downloading from a remote server, for example via the Internet.

[0020] The present invention will further be explained below with reference to exemplary embodiments illustrated in the accompanying drawings, in which;

Fig. 1 schematically shows a channel conversion device according to the Prior Art.
Fig. 2 schematically shows a first embodiment of a channel conversion device according to the present invention.
Fig. 3 schematically shows a second embodiment of the channel conversion device according to the present invention.
Fig. 4 schematically shows a third embodiment of the channel conversion device according to the present invention.
Fig. 5 schematically shows a fourth embodiment of the channel conversion device according to the present invention.
Fig. 6 schematically shows an audio system according to the present invention.

[0021] The Prior Art device 1' shown in Fig. 1 comprises an array 3 of decorreletion units and an upmix unit 4. The device has M inputs 5 and N outputs 6, which are all coupled to the upmix unit 4. Each input 5 receives an audio channel of a set of audio channels which together constitute a multiple-channel audio signal.

[0022] The number of output channels (N outputs 6) is greater than the number of input channels (M inputs 5). Exemplary values are N = 6 and M = 2, as when a stereo audio signal is converted into a 5.1 audio signal, or N = 2 and M = 1, as when a stereo signal is encoded as a mono signal plus additional information, although other values of M and N are also possible. The output channels typically have (mutual) correlations defined by parameters fed to the upmix

unit 4. To produce output channels having the desired correlations, a set of mutually uncorrelated channels is derived from the input channels. To this end, decorrelation units 3 are coupled to each input 5 so as to produce sets of uncorrelated input channels. The actual number of decorrelation filters, which are well known in the art, may vary and is not limited to the number shown in the drawings.

[0023] The decorrelation units 31, ..., 39 typically include filters having all-pass characteristics. Such filters substantially maintain the spectral envelope of the audio signal. However, the all-pass characteristics have the disadvantage of introducing a time delay. In addition, they often cause a "smearing" of the input signal, that is, the temporal envelope of the decorrelated signal is less well-defined than the temporal envelope of the original signal. Both the time delay and the "smearing" result in a discrepancy between the audio signal and the corresponding parameters: some signal parts (that is, time segments of the signal produced by decorrelation filters) reach the upmix unit later than the corresponding parameters. As a result, the wrong parameters are applied to these signal parts and the audio signal is processed incorrectly, leading to a perceptible signal distortion, for example crosstalk. It will be understood that this is highly undesirable.

[0024] It is noted that the parameters could be delayed (e.g. be a delay unit) so as to better match the timing of the parameters and the signals. However, the upmix unit 4 also receives the un-decorrelated input signals, which have not been delayed. In addition, the "smearing" may be frequency-dependent. As a result, it is difficult to match the parameters and the corresponding signal parts.

[0025] The present invention solves this problem by processing the audio signal prior to the decorrelation. That is, a substantial part of the signal processing is performed before the audio signal is fed to the decorrelation filters. In this way, the mismatch caused by the decorrelation filters is largely avoided.

[0026] The device 1 according to the present invention and illustrated merely by way of non-limiting example in Fig. 2 also comprises an array 3 of decorrelation filters (31, ...) and an upmix unit 4. In contrast to the Prior Art device 1' of Fig. 1, however, the device 1 of the present invention additionally comprises a pre-processing unit 2 for pre-processing the audio signal prior to the decorrelation.

[0027] The pre-processing unit 2 receives the M input channels of the audio signal through the M inputs 5. The unit 2 also receives parameters relating to the audio signal, which are indicative of desired signal properties. Using these parameters, the pre-processing unit 2 performs signal processing such as adjusting the power ratios of the audio channels and predicting some audio channels on the basis of other audio channels. As a result, power ratio adjustment and prediction are carried out without being influenced by the decorrelation filters 3, and any time mismatch between the audio signal and the parameters relating to these operations is avoided.

[0028] It will be understood that not all signal processing can be performed by the pre-processing unit. Setting the desired correlations of the audio channels typically requires the availability of uncorrelated channels as produced by the decorrelation filters 3. Accordingly, setting the correlations is performed by the upmix unit 4. In addition, additional signal adjustments may be made by the upmix unit 4, such as an additional adjustment of the power levels of the audio channels. In this case, the power adjustment may be carried out in both the pre-processing unit 2 and the upmix unit 4, although it is very well possible to perform this operation in only one of these units.

[0029] An additional advantage of the present invention is the possibility to choose which of the units 2 and 4 is best suitable for performing a certain signal processing operation. By providing two units (2 and 4) instead of a single unit (4), a greater design flexibility is achieved, and the unfavorable effects of the decorrelation units can be avoided to the greatest extent possible.

[0030] In the preferred embodiments of the present invention, the pre-processing unit 2 and the upmix unit 4 are both time-variant: their signal processing properties are controlled by signal parameters which may vary in time. The decorrelation filters 3, however, are preferably time-invariant: their properties are not time-dependent and are preferably not controlled by signal parameters that vary over time. Embodiments can be envisaged in which either the pre-processing unit 2 or the upmix unit 4 is time-invariant.

[0031] In further advantageous embodiments, the processing performed by the pre-processing unit 2 and/or the upmix unit 4 is frequency-dependent: the signal processing properties of these units may be controlled by parameters which vary in dependence of the frequency.

[0032] As mentioned above, the number of output channels (N) is greater than the number of input channels (M). For example, there may be two input channels and five or six output channels, or there may be a single input channel and two or more output channels, although other combinations are possible.

[0033] It is also possible that the number of output channels 6 is equal to the number of input channels 5 (that is, M = N), in which case the device of the present invention provides a remix of the audio channels. This may be useful to adjust certain signal properties and to enhance the audio signal.

[0034] It is noted that the audio signal may be constituted by a series of signal parts contained in consecutive time segments. Such time segments may be time frames or other units defining a time-limited signal part. Due to the decorrelation units the synchronization between the time segments and the corresponding parameters may be lost. This problem is solved by the present invention.

[0035] A merely exemplary embodiment of the device of the present invention is shown in more detail in Fig. 3. The device 1 of Fig. 3 receives a single channel audio input signal (M = 1). In the exemplary embodiment of Fig. 3 the pre-processing unit 2 comprises two gain units 22 and 23 having respective gains G_2 and G_3. The gain units 22 and 23 set the levels of the audio auxiliary channels before these auxiliary channels are decorrelated by respective decorrelation units 31, 32, 33 of a set (array) 3 of decorrelation units. Each of the decorrelation units 31, 32 and 33 has a respective transfer function H_1, H_2 and H_3 and produces a respective decorrelated auxiliary channel S_1, S_2 and S_3.

[0036] A (first) gain unit 21 having a gain G_1 could be added between the input terminal and the first decorrelation unit 31 but has been omitted from the embodiment shown where the first gain G_1 is equal to 1.

[0037] The upmix unit 4 comprises, in the example shown, three mixing units 41, 42 and 43 which mix the input channel and its three auxiliary channels to produce four output channels Lf (Left front), Ls (Left surround), Rf (Right front) and Rs (Right surround). The mixing unit 41 receives the (time-dependent) parameters IID_lr (Inter-channel Intensity Difference left - right) and ICC_lr (Inter-channel Cross-Correlation left - right), the mixing unit 42 receives the (time-dependent) parameters IID_1 (Inter-channel Intensity Difference left front - left surround) and ICC_1 (Inter-channel Cross-Correlation left front - left surround), while the mixing unit 43 receives the (time-dependent) parameters IID_r (Inter-channel Intensity Difference right front - right surround) and ICC_r (Inter-channel Cross-Correlation right front - right surround).

[0038] The parameters mentioned above are typically used in a so-called mixing matrix to determine the desired output signals. For example, the output signals Rf (Right front) and Rs (Right surround) may be determined by a mixing matrix M of mixing unit 43:

$$\begin{bmatrix} Rf \\ Rs \end{bmatrix} = \begin{bmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{bmatrix} \begin{bmatrix} R \\ H_3(G_3.S) \end{bmatrix} \tag{1}$$

where the matrix M has coefficients m_{11} ... m_{22}, and where $H_3(G_3.S) = S_3$ is the output signal of decorrelation unit 33. The normalized correlation coefficient ICC of the signals Rf and Rs is given by:

$$ICC(Rf, Rs) = \frac{m_{11}m_{21}\sigma_R^2 + m_{12}m_{22}\sigma_{S3}^2}{\sqrt{(m_{11}^2\sigma_R^2 + m_{12}^2\sigma_{S3}^2)(m_{21}^2\sigma_R^2 + m_{22}^2\sigma_{S3}^2)}} \tag{2}$$

where σ_x^2 is the power of signal x. The intensity ratio IID is given by:

$$IID(Rf, Rs) = \frac{(m_{11}^2\sigma_R^2 + m_{12}^2\sigma_{S3}^2)}{(m_{21}^2\sigma_R^2 + m_{22}^2\sigma_{S3}^2)} \tag{3}$$

[0039] As the total power should be unaltered, it follows that:

$$\sigma_R^2 = m_{11}^2\sigma_R^2 + m_{12}^2\sigma_{S3}^2 + m_{21}^2\sigma_R^2 + m_{22}^2\sigma_{H3}^2 \tag{4}$$

[0040] It has been found that the further constraint $m_{12} = -m_{22}$ is effective. In other words, the power of the intermediate signal (auxiliary channel) S_3 in both signals Rf and Rs is equal but has opposite signs (anti-phase). If $m_{12} = -m_{22}$ holds, the factors m_{12} and m_{22} can be moved upstream of decorrelator unit 33, for example to gain unit 23, to allow processing prior to decorrelation. Equation (1) can then be rewritten as:

$$\begin{bmatrix} R_f \\ R_s \end{bmatrix} = \begin{bmatrix} m_{11} & 1 \\ m_{21} & -1 \end{bmatrix} \begin{bmatrix} R \\ H_3(G_3.m_{12}.S) \end{bmatrix} \qquad (1')$$

[0041] Equation (1') can be generalized using a parameter c:

$$\begin{bmatrix} R_f \\ R_s \end{bmatrix} = \begin{bmatrix} m_{11} & c \\ m_{21} & -c \end{bmatrix} \begin{bmatrix} R \\ H_3(G_3.\dfrac{m_{12}}{c}.S) \end{bmatrix} \qquad (1'')$$

[0042] For c = 1 all time-variant processing of the decorrelator signal path is performed upstream of the decorrelator, while for $c = G_3.m_{12}$ all time-variant processing of the decorrelator signal path is performed downstream of the decorrelator. In accordance with the present invention, the parameter c will preferably have a value approximately or substantially equal to 1.

[0043] In the exemplary embodiment described above the upmix unit 4 sets both the cross-correlation and the intensity difference of the four output channels. This is, of course, not essential and in some embodiments the inter-channel intensity may be set in the pre-processing unit 2. This may be accomplished by performing all mixing operations in the pre-processing unit 2, for example directly using the input signal S.

[0044] It can be seen from Fig. 3 that in accordance with the present invention a pre-processing operation is carried out, in the example shown a gain (that is, power) adjustment.

[0045] Another example of a device 1 according to the present invention is illustrated in Fig. 4 where an audio signal comprised of two input audio channels L_0 and R_0 is converted into an audio signal consisting of five output audio channels Lf, Ls, C (Center), Rf and Rs. The pre-processing unit 2 comprises a single mixing unit 25 which receives the (time-dependent) signal parameters c_1 and c_2. The parameters c_1 and c_2 are prediction parameters for predicting the intermediate signals L, C and R output by the mixing unit 25 on the basis of the input signals L_0 and R_0. The decorrelation units 31 and 32 produce uncorrelated counterparts of the intermediate channels L and R which are then fed to the upmix unit 4. The operation of the mixing units 41 and 42 of the upmix unit 4 is similar to the operation of the mixing units 41 - 43 in the embodiment of Fig. 3.

[0046] As can be seen from Fig. 4, part of the processing is carried out by the processing unit 4, prior to the decorrelation. This is particularly advantageous when prediction is used as decorrelators tend to distort the original waveform, while a correct prediction requires the original waveforms to be unaltered. Prediction carried out before decorrelation therefore yields much better results. It will be understood that instead of a single pre-processing unit 2, two or more of such units may be present, for example one pre-processing unit performing prediction operations and another pre-processing unit performing mixing and/or scaling operations.

[0047] An exemplary stereo decoder in accordance with the present invention is illustrated in Fig. 5. The stereo decoder of Fig. 5 is essentially a device 1 according to the present invention having a single input (M = 1) and two outputs (N = 2). The pre-processing unit 2 performs a scaling operation (gain G) and produces two intermediate channels, one of which is decorrelated by the decorrelation unit 3 (transfer function H). An upmix unit 4 performs a rotation operation (Rot) so to rotate the spatial orientation of the signal. It is noted that multiple channel signal rotation is well known in the art. Signal rotation is discussed in more detail in International Patent Application WO 03/090206 (Applicant's Reference PHNL020639EPP), the entire contents of which are herewith incorporated in this document.

[0048] An audio system 10 according to the present invention is schematically illustrated in Fig. 6. The audio system 10 is shown to comprise a device 1 for converting a first number of input audio channels into a second number of output audio channels as discussed above.

[0049] Accordingly, the present invention may be used in audio amplifiers and/or systems. Such audio systems may include one or more audio sources, an amplifier and loudspeaker units or their equivalents. The audio sources may include a CD player, a DVD player, an MP3 or AAC player, a radio tuner, a hard disk, and/or other sources. The audio system may be incorporated in an entertainment center or in a computer system.

[0050] As discussed above, the present invention provides both a device and a method. The method steps are evident from Fig. 2, where the step of pre-processing the input audio channels prior to the step of decomposing the input audio channels into a set of decorrelated auxiliary channels is carried out by the pre-processing unit 2, the step of decomposing

the input audio channels into a set of decorrelated auxiliary channels is carried out by the array 3 of decorrelation units (31, 32, ...), and the step of converting the decorrelated auxiliary channels, preferably in combination with the input audio channels and/or any intermediate channels, into the output audio channels is carried out by the upmix unit 4.

[0051] The present invention is based upon the insight that the time delay and possible "smearing" caused by the decorrelation in an audio decoder may cause temporal alignment discrepancies between the signal parameters and the corresponding signal parts. The present invention benefits from the further insight that this discrepancy can be eliminated, at least for certain signal processing operations, by carrying out these operations prior to the decorrelation.

[0052] It is noted that any terms used in this document should not be construed so as to limit the scope of the present invention. In particular, the words "comprise(s)" and "comprising" are not meant to exclude any elements not specifically stated. Single (circuit) elements may be substituted with multiple (circuit) elements or with their equivalents.

[0053] It will be understood by those skilled in the art that the present invention is not limited to the embodiments illustrated above and that many modifications and additions may be made without departing from the scope of the invention as defined in the appending claims.

Claims

1. A device (1) for converting a first number (M) of input audio channels into a second number (N) of output audio channels, where the first number (M) is smaller than the second number (N), the device comprising:

   - at least one decorrelation unit (3) for producing a set of decorrelated auxiliary channels from an input audio channel, the set of decorrelated auxiliary channels including one or more decorrelated auxiliary channels; and
   - at least one upmix unit (4) for combining channels into output audio channels, wherein the at least one upmix unit (4) is operative to combine an input audio channel or a prs-processed input audio channel and a decorrelated auxiliary channel based on a time-varying inter-channel cross correlation parameter, said device further comprising:
   - at least one pre-processing unit (2) for pre-processing the input audio channel prior to feeding the input audio channel to the at least one decorrelation unit (3), wherein the at least one pre-processing unit (2) is operative to perform a time-varying signal processing other than setting correlations.

2. The device according to claim 1, wherein the at least one pre-processing unit (2) and the at least one upmix unit (4) are controlled by audio parameters.

3. The device according to claim 1, wherein the at least one pre-processing unit (2) is arranged for time-variant pre-processing.

4. The device according to claim 1, wherein the at least one decorrelation unit (3) is arranged for time-invariant decorrelation.

5. The device according to claim 1, wherein the upmix unit (4) is arranged for time-variant decorrelation.

6. The device according to claim 1, wherein the pre-processing unit (2) is arranged for setting power ratios of audio channels and/or for prediction.

7. The device according to claim 1, wherein the first number (M) is equal to one.

8. The device according to claim 1, wherein the first number (M) is equal to two.

9. An audio system (10), comprising a device according to claim 1.

10. A method of converting a first number (M) of input audio channels into a second number (N) of output audio channels, where the first number (M) is smaller than the second number (N), the method comprising the steps of:

    - producing a set of decorrelated auxiliary channels from an input audio channel, the set of decorrelated auxiliary channels including one or more decorrelated auxiliary channels; and
    - combining channels into output audio channels, wherein the step of combining comprising combining an input audio channel or a pre-processed input audio channel and a decorrelated auxiliary channel based on a time-varying inter-channel cross correlation parameter, said method comprising the additional step of:

- pre-processing the input audio channel prior to the step of producing the set of decorrelated auxiliary channels from the input audio channel, wherein the step of pre-processing comprises performing a time-varying signal processing other than setting correlations.

11. The method according to claim 10, wherein audio parameters are used in the combining step and the pre-processing step.

12. The method according to claim 10, wherein the step of pre-processing comprises the sub-steps of setting power ratios of audio channels and/or of prediction.

13. A computer program product for carrying out the method according to claim 10.

Patentansprüche

1. Eine Vorrichtung (1) zum Umwandeln einer ersten Anzahl (M) aus Eingangsaudiokanälen in eine zweite Anzahl (N) aus Ausgangsaudiokanälen, wobei die erste Anzahl (M) kleiner ist als die zweite Anzahl (N), wobei die Vorrichtung folgende Merkmale aufweist:

zumindest eine Dekorrelationseinheit (3) zum Erzeugen eines Satzes aus dekorrelierten Hilfskanälen aus einem Eingangsaudiokanal, wobei der Satz aus dekorrelierten Hilfskanälen einen oder mehrere dekorrelierte Hilfskanäle umfasst; und
zumindest eine Aufwärtsmischeinheit (4) zum Kombinieren von Kanälen in Ausgangsaudiokanäle, wobei die zumindest eine Aufwärtsmischeinheit (4) wirksam ist, um einen Eingangsaudiokanal oder einen vorverarbeiteten Eingangsaudiokanal und einen dekorrelierten Hilfskanal basierend auf einem zeitvariablen Zwischenkanal-Kreuzkorrelationsparameter zu kombinieren, wobei die Vorrichtung ferner folgendes Merkmal aufweist:

zumindest eine Vorverarbeitungseinheit (2) zum Vorverarbeiten des Eingangsaudiokanals vor dem Zuführen des Eingangsaudiokanals zu der zumindest einen Dekorrelationseinheit (3), wobei die zumindest eine Vorverarbeitungseinheit (2) wirksam ist, um eine zeitvariable Signalverarbeitung auszuführen, abgesehen von dem Einstellen von Korrelationen.

2. Die Vorrichtung gemäß Anspruch 1, bei der die zumindest eine Vorverarbeitungseinheit (2) und die zumindest eine Aufwärtsmischeinheit (4) durch Audioparameter gesteuert sind.

3. Die Vorrichtung gemäß Anspruch 1, bei der die zumindest eine Vorverarbeitungseinheit (2) für eine zeitvariable Vorverarbeitung angeordnet ist.

4. Die Vorrichtung gemäß Anspruch 1, bei der die zumindest eine Dekorrelationseinheit (3) für eine nicht zeitvariable Dekorrelation angeordnet ist.

5. Die Vorrichtung gemäß Anspruch 1, bei der die Aufwärtsmischeinheit (4) für eine zeitvariable Dekorrelation angeordnet ist.

6. Die Vorrichtung gemäß Anspruch 1, bei der die Vorverarbeitungseinheit (2) zum Einstellen von Leistungsverhältnissen von Audiokanälen und/oder zur Vorhersage angeordnet ist.

7. Die Vorrichtung gemäß Anspruch 1, bei der die erste Anzahl (M) gleich eins ist.

8. Die Vorrichtung gemäß Anspruch 1, bei der die erste Anzahl (M) gleich zwei ist.

9. Ein Audiosystem (10), das eine Vorrichtung gemäß Anspruch 1 aufweist.

10. Ein Verfahren zum Umwandeln einer ersten Anzahl (M) aus Eingangsaudiokanälen in eine zweite Anzahl (N) aus Ausgangsaudiokanälen, wobei die erste Anzahl (M) kleiner ist als die zweite Anzahl (N), wobei das Verfahren folgende Schritte aufweist:

Erzeugen eines Satzes aus dekorrelierten Hilfskanälen aus einem Eingangsaudiokanal, wobei der Satz aus

dekorrelierten Hilfskanälen einen oder mehrere dekorrelierte Hilfskanäle umfasst; und
Kombinieren von Kanälen in Ausgangsaudiokanäle, wobei der Schritt des Kombinierens das Kombinieren eines Eingangsaudiokanals oder eines vorverarbeiteten Eingangsaudiokanals und eines dekorrelierten Hilfskanals basierend auf einem zeitvariablen Zwischenkanal-Kreuzkorrelationsparameter aufweist, wobei das Verfahren ferner folgenden Schritt aufweist:

Vorverarbeiten des Eingangsaudiokanals vor dem Schritt des Erzeugens des Satzes aus dekorrelierten Hilfskanälen aus dem Eingangsaudiokanal, wobei der Schritt des Vorverarbeitens das Ausführen einer zeitvariablen Signalverarbeitung aufweist, abgesehen von dem Einstellen von Korrelationen.

11. Das Verfahren gemäß Anspruch 10, bei dem Audioparameter bei dem Kombinierschritt und dem Vorverarbeitungs-schritt verwendet werden.

12. Das Verfahren gemäß Anspruch 10, bei dem der Schritt des Vorverarbeitens die Teilschritte des Einstellens der Leistungsverhältnisse von Audiokanälen und/oder der Vorhersage aufweist.

13. Ein Computerprogrammprodukt zum Ausführen des Verfahrens gemäß Anspruch 10.

Revendications

1. Dispositif (1) pour convertir un premier nombre (M) de canaux audio d'entrée, pour obtenir un deuxième nombre (N) de canaux audio de sortie, dans lequel le premier nombre (M) est inférieur au deuxième nombre (N), le dispositif comprenant:

- au moins une unité de décorrélation (3) destinée à produire un ensemble de canaux auxiliaires décorrélés à partir d'un canal audio d'entrée, l'ensemble de canaux auxiliaires décorrélés comportant un ou plusieurs canaux auxiliaires décorrélés; et
- au moins une unité de mélange ascendant (4) destinée à combiner les canaux, pour obtenir des canaux audio de sortie, où l'au moins une unité de mélange ascendant (4) est opérationnelle pour combiner un canal audio d'entrée ou un canal audio d'entrée prétraité et un canal auxiliaire décorrélé sur base d'un paramètre de cor-rélation croisée entre canaux variable dans le temps, ledit dispositif comprenant par ailleurs:
- au moins une unité de prétraitement (2) destinée à prétraiter le canal audio d'entrée avant d'alimenter le canal audio d'entrée vers l'au moins une unité de décorrélation (3), où l'au moins une unité de prétraitement (2) est opérationnelle pour effectuer un traitement de signal variable dans le temps autre que le réglage de corrélations.

2. Dispositif selon la revendication 1, dans lequel l'au moins une unité de prétraitement (2) et l'au moins une unité de mélange ascendant (4) sont commandés par les paramètres audio.

3. Dispositif selon la revendication 1, dans lequel l'au moins une unité de prétraitement (2) est aménagée pour un prétraitement variable dans le temps.

4. Dispositif selon la revendication 1, dans lequel l'au moins une unité de décorrélation (3) est aménagée pour une décorrélation invariable dans le temps.

5. Dispositif selon la revendication 1, dans lequel l'unité de mélange ascendant (4) est aménagée pour une décorrélation variable dans le temps.

6. Dispositif selon la revendication 1, dans lequel l'unité de prétraitement (2) est aménagée pour régler les rapports de puissance des canaux audio et/ou pour une prédiction.

7. Dispositif selon la revendication 1, dans lequel le premier nombre (M) est égal à un.

8. Dispositif selon la revendication 1, dans lequel le premier nombre (M) est égal à deux.

9. Système audio (10), comprenant un dispositif selon la revendication 1.

10. Procédé pour convertir un premier nombre (M) de canaux audio d'entrée, pour obtenir un deuxième nombre (N) de

canaux audio de sortie, dans lequel le premier nombre (M) est inférieur au deuxième nombre (N), le procédé comprenant les étapes consistant à:

- produire un ensemble de canaux auxiliaires décorrélés à partir d'un canal audio d'entrée, l'ensemble de canaux auxiliaires décorrélés comportant un ou plusieurs canaux auxiliaires décorrélés; et
- combiner les canaux, pour obtenir des canaux audio de sortie, où l'étape consistant à combiner comprend le fait de combiner un canal audio d'entrée ou un canal audio d'entrée prétraité et un canal auxiliaire décorrélé sur base d'un paramètre de corrélation croisée entre canaux variable dans le temps, ledit procédé comprenant l'étape supplémentaire consistant à:
- prétraiter le canal audio d'entrée avant l'étape consistant à produire l'ensemble de canaux auxiliaires décorrélés à partir d'un canal audio d'entrée, où l'étape consistant à prétraiter comprend le fait d'effectuer un traitement de signal variable dans le temps autre que le réglage de corrélations.

11. Procédé selon la revendication 10, dans lequel les paramètres audio sont utilisés à l'étape consistant à combiner et à l'étape consistant à prétraiter.

12. Procédé selon la revendication 10, dans lequel l'étape consistant à prétraiter comprend les sous-étapes consistant à régler les rapports de puissance des canaux audio et/ou de prédiction.

13. Programme d'ordinateur pour réaliser le procédé selon la revendication 10.

Parameters

Input 1

5

H_{11}

31

H_{1k}

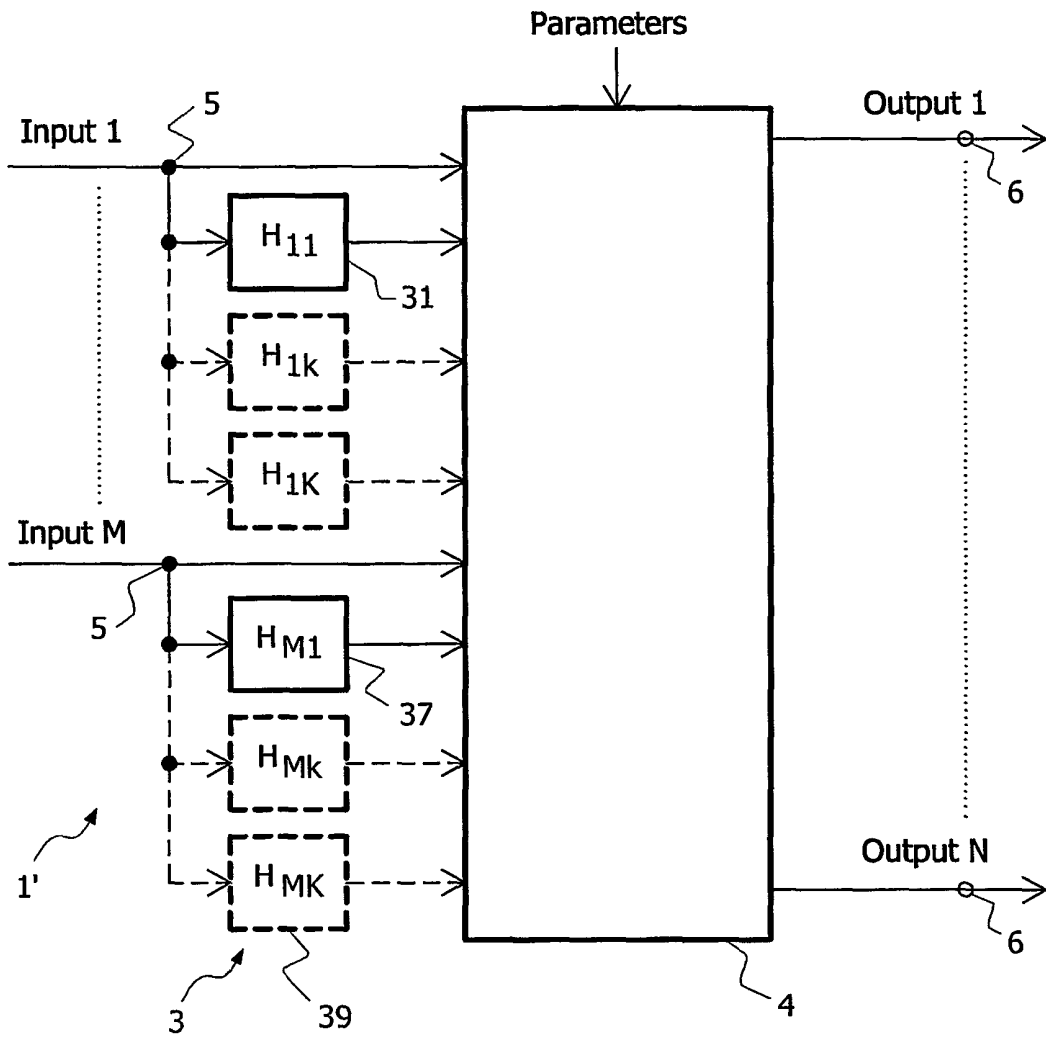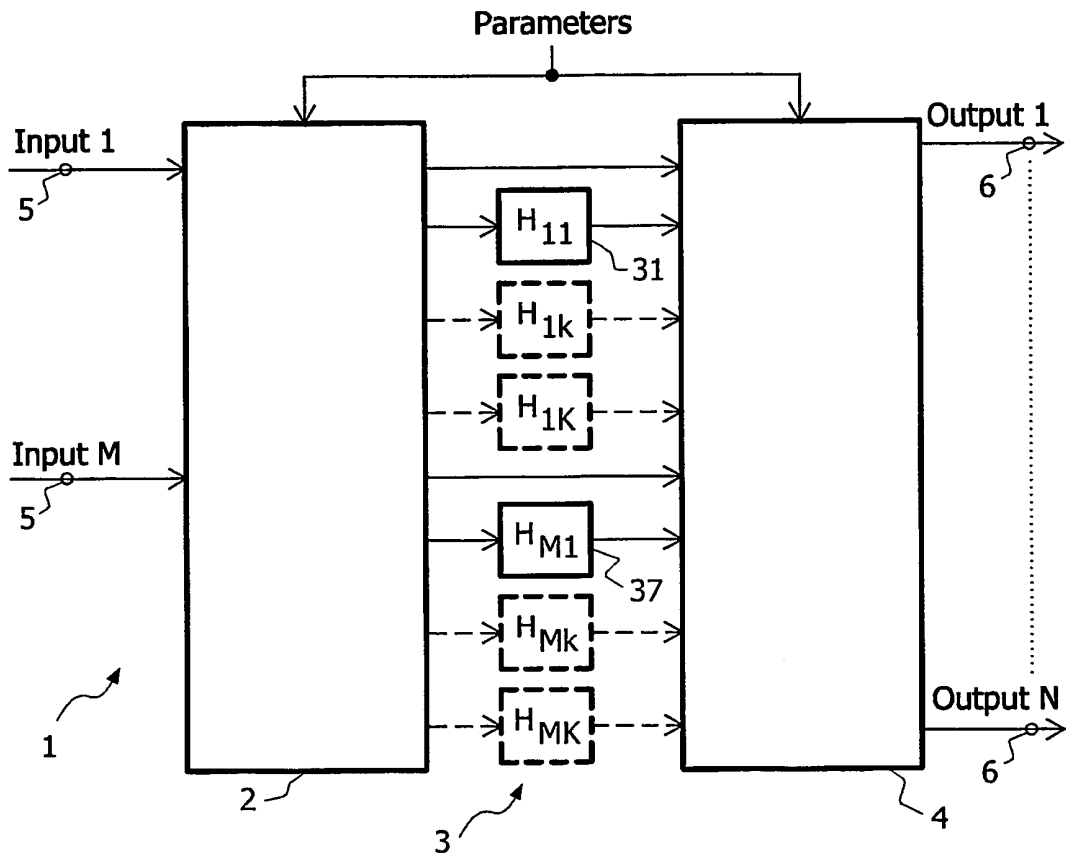H_{1K}

Input M

5

H_{M1}

37

H_{Mk}

H_{MK}

1'

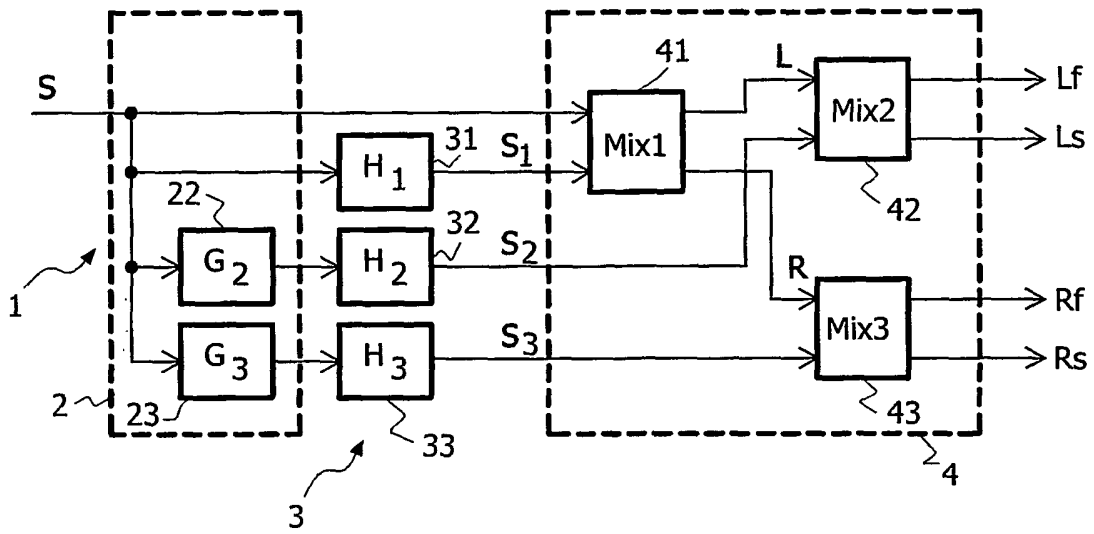3   39

4

Output 1

6

Output N

6

FIG. 1

FIG. 2

FIG. 3
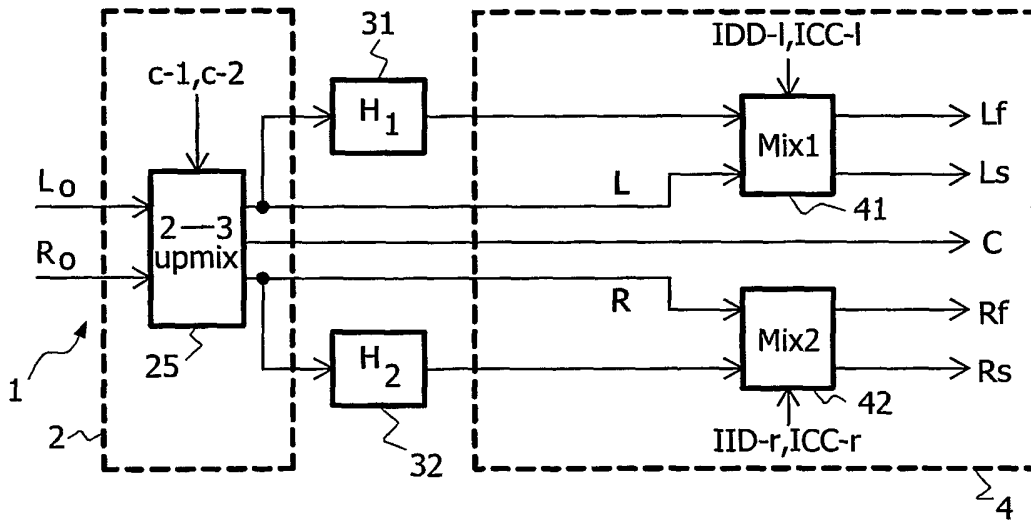
FIG. 4
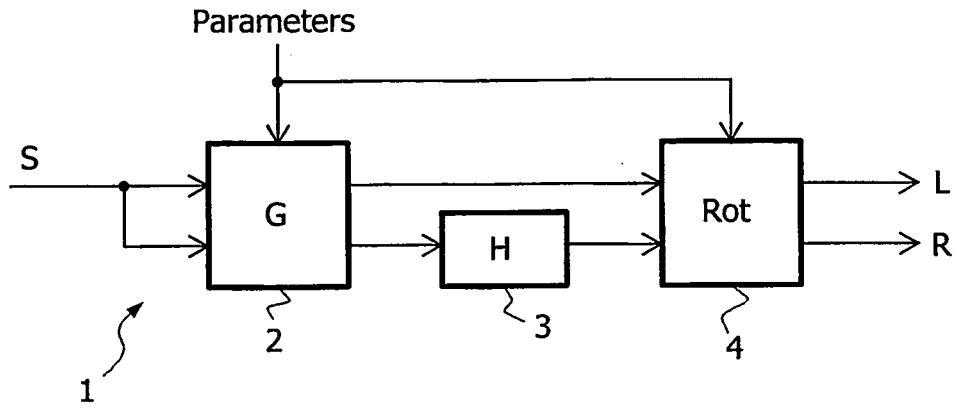
FIG. 5
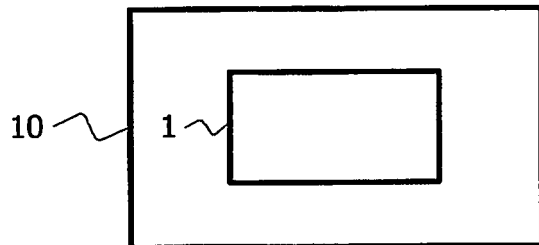
FIG. 6

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- WO 03090206 A **[0047]**